IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	: Colbert, et al.	Art Unit	: 1754
Serial No.	: 10/670,955	Examiner	: James Fiorito
Filed	: September 25, 2003	Conf. No.	: 7093
Title	: METHOD FOR END-DERIVATIZING SINGLE-WALL CARBON NANOTUBES (AS AMENDED)		

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AMENDED BRIEF ON APPEAL

Pursuant to the Notification of Non-Compliant Appeal Brief dated June 18, 2007, Applicant has amended its Brief on Appeal filed May 9, 2007 so that it is now in compliance. In particular the items specified with the Notification of Non-Compliance have been corrected. *See* Section V at page 2 of the Amended Brief.

The original Brief on Appeal, filed May 9, 2007, was submitted pursuant to the Notice of Appeal filed in the U.S. Patent and Trademark Office on March 9, 2007, and in support of the appeal from the Final Rejection set forth in the Office Action mailed on September 11, 2006.

I. REAL PARTY-IN-INTEREST

The real party-in-interest is William Marsh Rice University, the assignee of the entire right and interest in the present Application.

II. RELATED APPEALS AND INTERFERENCES

There are no appeals or interferences known to Appellant, the Appellant's legal representative, or assignee that will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. STATUS OF CLAIMS

Claims 84-85, 91-92, and 94-95 are pending in the Application.

Claims 84-85, 91-92, and 94-95 stand rejected.

Claims 84-85, 91-92, and 94-95 are being appealed.

IV. STATUS OF AMENDMENTS

There were no amendments to the claims or Specification filed after the Final Rejection.

V. SUMMARY OF THE CLAIMED SUBJECT MATTER

The claims relate to a method for end-derivatizing single-wall carbon nanotubes. A brief explanation of single-wall carbon nanotubes is given in the Application at page 25, line 25, through page 27, line 3.

Tubular carbon molecules can be chemically derivatized at their ends (which may be made either open or closed with a hemi-fullerene dome). Application, at 34, *ll.* 11-13. Alternatively, the fullerene caps of the single-walled nanotubes (SWNT) may be removed at one or both ends of the tubes by short exposure to oxidizing conditions (*e.g.*, with nitric acid or O_2/CO_2) sufficient to open the tubes but not etch them back too far, and the resulting open tube ends may be derivatized using known reaction schemes for the reactive sites at the graphene sheet edge. *Id.*, at 34, *ll.* 17-22. Derivatives and substituents are shown on in the Application on page 34, *l.* 23 through page 37, *l.* 16.

According to one of the independent claims, Claim 84, the method for end-derivatizing single-wall carbon nanotubes in the claimed invention comprises the steps of a) providing a plurality of single-wall carbon nanotubes; and b) reacting the single-wall carbon nanotubes with a compound that provides at least one substituent on at least one of the ends of at least a portion of the single-wall carbon nanotubes. The method is described in the application at page 34, line 10 through page 37, line 16.

According to another of the independent claims, Claim 91, the method for end-derivatizing single-wall carbon nanotubes in the claimed invention comprises a method for producing end-derivatized single-wall carbon nanotubes comprising the steps of a) providing a plurality of single-wall carbon nanotubes, wherein the carbon nanotubes comprise at least about 100 carbon atoms; and b) reacting the single-wall carbon nanotubes with a compound that

provides at least one substituent on at least one of the ends of at least a portion of the single-wall carbon nanotubes. The method is described in the application at page 34, line 10 through page 37, line 16.

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

A. Claims 94-95 stand rejected under 35 U.S.C. § 112, ¶ 1, as failing to comply with the written description requirement.

B. Claims 84-85, 91-92, and 94-95 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,698,175 to Hiura ("*Hiura*") in view of "Single-shell carbon nanotubes of 1-nm diameter," Iijima *et al.*, *Nature*, Vol. 363, pp.603-605 ("*Iijima*").

VII. ARGUMENTS

A. Claims 94 and 95 Comply With 35 U.S.C. § 112, ¶ 1

Examiner has rejected Claim 94 and 95 under 35 U.S.C. § 112, ¶ 1, as failing to comply with the written description requirement. Final Office Action, at 2.

The Examiner contends that the instant specification teaches that "[t]he ends of the single-wall carbon nanotubes are open, or closed. However, a combination of open and closed nanotubes is not taught in the specification." *Id.*

Applicant traverses these rejections.

1. Claim 94

Support for the combination of open and closed nanotubes is taught multiple times in the Application, for example, as cited below.

> Fullerene tubes may be closed at one or both ends with end caps or open at one or both ends.

Application, at 25, *ll.* 16-17.

> The nanotube can have a fullerene cap (e.g., hemispheric) at one end of the cylinder and a similar fullerene cap at the other end. One or both ends can also be open.

Id. at 33, *ll.* 24-26.

> The tubular carbon molecules (including the multiwall forms) produced as described above can be chemically derivatized at their ends (which may be made either open or closed with a hemi-fullerene dome).

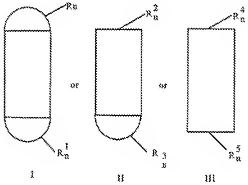
Id., at 34, *ll.* 11-13.

> Alternatively, the fullerene caps of the single-walled nanotubes may be removed at one or both ends of the tubes by short exposure to oxidizing conditions (e.g., with nitric acid or O_2/CO_2) sufficient to open the tubes but not etch them back too far, and the resulting open tube ends maybe derivatized using known reaction schemes for the reactive sites at the graphene sheet edge.

Id., at 34, *ll.* 17-22.

In addition, the combinations of end-derivatized single-wall carbon nanotubes are diagrammed, as shown below:

In general, the structure of such molecules can be shown as follows:



Id., at 34, *ll.* 23-25.

In these three molecules diagrammed in the Application and reproduced above, the vertical rectangular boxes are each a "substantially defect-free cylindrical graphene sheet (which optionally can be doped with non-carbon atoms) having from about 10^2 to about 10^6 carbon atoms, and having a length of from about 5 to about 1000 nm, preferably about 5 to about 500 nm" *i.e.*, the tube section of a single-wall carbon nanotube. *Id.*, at 35, *ll.* 6-10. Moreover, in these three molecules reproduced above, the semi-circles are each "a fullerene cap that fits perfectly on the cylindrical graphene sheet, has at least six pentagons and the remainder hexagons and typically has at least about 30 carbon atoms.," *i.e.*, an end cap of a single-wall

carbon nanotube. *Id.*, at 35, *ll.* 12-15. Hence, the second molecule (II) reproduced above is a single-wall carbon nanotube with one end opened and the other end closed.

In light of the foregoing, the claimed subject matter was described in the specification in such a way as to reasonably convey such subject matter to one skilled in the art. Therefore, Claim 94 meets the written description requirement and would be understood by a person skilled in the art.

Accordingly, Claim 94 complies with the written description requirement under § 112, ¶ 1.

2. Claim 95

For the reasons discussed in Section VII.A.1 above, Claim 95 meets the written description requirement and would be understood by a person skilled in the art. Accordingly, Claim 95 also complies with the written description requirement under § 112, ¶ 1.

B. <u>35 U.S.C. § 103(a) Rejections</u>

The Examiner has rejected Claims 84-85, 91-92, and 94-95 under 35 U.S.C. § 103(a) as being unpatentable over *Hiura* in view of *Iijima*. In both the first Office Action of March 28, 2006 ("Office Action") and the Final Office Action of September 11, 2006, ("Final Office Action"), the Examiner contended that:

> *Hiura* discloses a method for producing end-derivatized carbon nanotubes comprising the steps of: a) providing a plurality of carbon nanotubes with at least about 100 carbon atoms; and b) reacting the carbon nanotubes with a compound that provides at least one substituent on at least one of the ends of least a portion of the carbon nanotubes (Abstract). At least one substituent is selected from the group consisting of alkyl; acyl; aryl; aralkyl; halogen; substituted thiol; unsubstituted thiol; substituted amino; unsubstituted amino; hydroxyl (Column 3). The derivatized carbon nanotubes are inherently soluble in some medium.

Office Action, at 3-4 and Final Office Action, at 3.

Applicant traverses these rejections.

1. Claim 84

Applicant presented arguments in reply to the Office Action and the Final Office Action in the Amendment Under 37 C.F.R. § 1.111, filed June 26, 2006 ("the 1.111 Amendment") and

Amendment Under 37 C.F.R. § 1.116, filed November 13, 2006 ("the 1.116 Amendment"), respectively.

In its recent opinion in *KSR Int'l Co. v. Teleflex, Inc.*, No. 04-1350 (U.S. Apr. 30, 2007), the Supreme Court reaffirmed the *Graham* factors in the determination of obviousness under § 103. *KSR Int'l*, slip op., at 2. The four factual inquiries under *Graham* are:

(a) determining the scope and content of the prior art;

(b) ascertaining the differences between the prior art and the claims in issue;

(c) resolving the level of ordinary skill in the pertinent art; and

(d) evaluating evidence of secondary consideration.

Id. (quoting *Graham v. John Deere*, 383 U.S. 1, 17-18, 148 U.S.P.Q. 459, 467 (1966)).

The Supreme Court further noted the obviousness analysis under § 103 should be explicit, and that it was "important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the [prior art] elements" in the manner claimed. The Court expressly held:

> Often, it will be necessary . . . to look to interrelated teachings of multiple patents; the effects of demands known to the design community or present in the marketplace; and the background knowledge possessed by a person having ordinary skill in the art, all in order to determine whether there was an ***apparent reason*** to combine the known elements in the fashion claimed by the patent at issue. To facilitate review, this analysis ***should be made explicit***.

KSR Int'l, slip op., at 14 (emphasis added). Accordingly, when rejecting a claim based upon a combination of prior art references, it remains necessary to identify the reason why a person of ordinary skill in the art of the patent would have combined the prior art elements in the manner claimed.

Moreover, there must be a reasonable expectation of success when combining these references, which reasonable expectation must be found in the prior art and not based upon applicant's disclosure. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. *See* M.P.E.P. 706.02(j); *see also In re Vaeck*, 947 F.2d 488, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991).

a. There Are Crucial Differences Between *Hiura* And *Iijima* And The Claims At Issue

When performing an obviousness analysis, the scope and contents of the prior art must be determined and the differences between the prior art and the claims-in-issue must be ascertained. *KSR Int'l*, slip op., at 2; *Graham*, 383 U.S. at 17-18. In the present Application, the Examiner has acknowledged that "*Hiura* does not expressly state that the carbon nanotubes are single-wall carbon nanotubes." Office Action, at 4 and Final Office Action, at 3. The fact that the processes disclosed in *Hiura* relate to ***multi-wall*** carbon nanotubes and not single-wall carbon nanotubes is critical because there are significant differences in terms of structure, properties, and chemical reactivity between multi-wall and single-wall carbon nanotubes.

The distinction between single-wall and multi-wall carbon nanotubes is important because multi-wall carbon nanotubes are fundamentally different from single-wall carbon nanotubes. Single-wall carbon nanotubes are molecules of carbon, while multi-wall carbon nanotubes are assemblies of carbon. Single-wall carbon nanotubes have only a single layer of sp^2-hybridized carbon atoms generally arranged in hexagons and pentagons. Because of their single-layer, single-wall carbon nanotubes generally cannot support defects in growth and are more susceptible to destruction by bond breakage or reaction. In contrast, multi-wall carbon nanotubes are composed of multiple, cylindrical concentric carbon layers arranged in a nested or scrolled fashion. Because of this arrangement, the carbon shells of multi-wall carbon nanotubes can withstand wall defects, which often appear as dislocations, kinks, holes, edges on the side-wall surfaces, *etc*. Also because of their multiple layers and the interconnections between these layers, multi-wall nanotubes (in comparison to single-wall nanotubes) can withstand much more rigorous chemical processing, physical conditions, and extensive chemical bond breakage without nanotube destruction.

Single-wall carbon nanotubes "rope" together and are held tightly by van der Waals forces. As such, single-wall nanotubes are difficult to separate and disperse in other media, while multi-wall nanotubes do not share the same propensity to rope and, as such, are readily separable and dispersible. The structural differences between single-wall and multi-wall carbon nanotubes also leads to differences in physical and chemical properties, such as tensile strength, modulus, flexibility, thermal conductivity, electrical conductivity, chemical reactivity and chemical stability.

As a result of such differences, the chemistry that can be done with each species is quite different and would be unpredictable.

b. There Is No Reasonable Expectation Of Success

Hiura primarily teaches the purification of multi-wall carbon nanotubes. Such purification is carried out by reacting such nanotubes with highly oxidative acids and/or oxidation agents under reflux and/or ultrasonic conditions. This purification damages the multi-wall structures, as shown graphically in *Hiura* (Fig. 3). Application of the teachings of *Hiura* to multi-wall carbon nanotubes, typically riddled with defects, results in the breaking of carbon-carbon bonds generally at regions of defects on the walls as well as the ends. *See Hiura* at Figure 3. However, because of their multi-wall structure, the multi-wall nanotubes can withstand attack to their wall layers and still remain intact. As would be appreciated by one of skill in the art, such bond splitting with single-wall carbon nanotubes would be expected to result in destruction of the single-wall nanotubes. Rather than expect the process of *Hiura* to succeed with single-wall carbon nanotubes, it was reasonable to believe such processes would destroy them. Hence, not only would the teachings of *Hiura* when combined with the teachings of *Iijima* not have suggested a reasonable likelihood of success as applied to single-wall carbon nanotubes, such a chemical protocol would be expected to fail to achieve the desired results.

c. The Level Of Ordinary Skill In The Pertinent Art Must Be Resolved

The third *Graham* factor is to resolve the level of ordinary skill in the pertinent art. *KSR Int'l*, slip op., at 2; *Graham*, 383 U.S. at 17-18. A person of ordinary skill in the art of the Application at the time of the invention would not reasonably have expected the process of *Hiura* would succeed for single-wall carbon nanotubes. Rather, and as noted above, a person of ordinary skill in the art would have reasonably believed the *Hiura* process would destroy the single-wall carbon nanotubes, which, in fact, was a view that was widely held by those skilled in the art well after the publication dates of *Hiura* and *Iijima*, as confirmed by Dujardin *et al.*, "Purification of Single-Shell Nanotubes," *Adv. Mater.*, **10**, No. 8, 611-613 (1998) ("*Dujardin*"), attached as Exhibit A hereto.

Dujardin notes that "[i]t was believed that purification of single-shell nanotubes based on preferential oxidation and/or separation using surfactants was much more difficult that that of [multi-shell] nanotubes." *Dujardin*, at 611. A reason for this was because "gas-phase oxidation,

which yields purified multishell nanotubes, destroys the single-shell nanotubes before anything else in the sample." *Id.* Thus, at the time of the invention, a person of ordinary skill in the art would have understood that, under the teachings of *Hiura*, the multi-wall carbon nanotubes were damaged by the disclosed process and resulted in the breaking of carbon-carbon bonds generally at regions of defects on the walls and ends of the multi-wall carbon nanotubes. Such a person of ordinary skill would have further recognized that, because of the multi-wall structure of the carbon nanotubes being tested in *Hiura*, those carbon nanotubes would have withstood the attack to their wall layers and would still have remained intact. However, such person would also have expected that the bond splitting that was occurring in the *Hiura* process would have also destroyed single-wall carbon nanotubes.

Thus, not only would have it not been obvious to one of ordinary skill in the art to apply the processes of *Hiura* to the nanotubes of *Iijima* to achieve the end-derivatization of single-wall carbon nanotubes, one of ordinary skill in the art would have been discouraged to apply the processes of *Hiura* to the nanotubes of *Iijima* because there would not be a reasonable expectation of success.

d. Examiner Must Consider The Objective Evidence

The fourth *Graham* factor is the evaluation of evidence of secondary consideration. *KSR Int'l*, slip op., at 2; *Graham*, 383 U.S. at 17-18.

i. The Examiner Did Not Properly Consider The Objective Evidence In The Office Actions

Nonetheless, it appears the Examiner ignores evidence of secondary consideration pertaining *Dujardin* and the statements made therein, because, according to Examiner, these statements apply to only gas-phase oxidation of multi-shell nanotubes. Final Office Action, at 5. This is not so. First of all, one of the authors of *Dujardin* is Prof. T. W. Ebbesen. *Dujardin*, at 611. Dr. Ebbesen is also, in fact, a named co-inventor of *Hiura*. *Hiura*, at cover page. Hence, there can be no dispute that the authors of *Dujardin* were fully cognizant of the processes disclosed in *Hiura*, when providing this statement.

However, any question as that this statement applied also to the processes disclosed in *Hiura* is completed negated by looking at the endnotes specifically in *Dujardin*. In particular, at the end of the quoted sentence in *Dujardin*, the authors referenced 4 papers, including as end

note [6]. H. Hiura, T.W. Ebbesen, K. Tanigaki, *Adv. Mater.*, **1995**, 7, 275. *See Dujardin*, at 611 & 613. This reference ("*1995 Hiura*"), is entitled, "Opening and Purification of Carbon Nanotubes in High Yields," and is attached at Exhibit B hereto. This paper makes clear the authors (which included both Dr. Hidefumi Hiura, and Dr. T.W. Ebbesen, the named inventors of *Hiura*), were trying "well-known oxidants, such as nitric acid, sulfuric acid, the mixture of both and potassium permanganate" for opening and purifying multi-shelled carbon nanotubes. *1995 Hiura*, at 275. Thus, the statement made in *Dujardin* applies to liquid-phase oxidation (as well as gas-phase oxidation) of multi-shell nanotubes. And, therefore, *Dujardin* directly shows that a person of ordinary skill in the art would not have expected, at the time of the invention, the results shown in the present Application. For that matter, this evidence clearly shows that even the inventors of *Hiura* would not have expected this result.

Examiner further asserted that the argument presented by the Applicant was "unpersuasive because the instant process is also carried out by reacting nanotubes with highly oxidative acids and/or oxidation agents under reflux conditions. Therefore, it appears that the process of *Hiura* in view of *Iijima* and the instantly claimed process would produce similar results." Final Office Action, at 4. In other words, the Examiner is relying on Applicant's own disclosure to argue that the unexpected result was expected. It is clearly in error to rely on Applicant's own disclosure in this manner, because, if this were allowed then there would never be "unexpected results" when the results of the applied for invention could be used to determine what a person of ordinary skill would have expected. In short, to protect against a hindsight analysis, the Applicant's own disclosure cannot be utilized in this manner.

Accordingly, it is impermissible to rely on the Applicant's disclosure to show the invention was expected and the Examiner cannot ignore the statements made in the art that show that a person of ordinary skill in the art would reasonably have been believed that the *Hiura* process would destroy single-wall carbon nanotubes.

Evidence of unexpected results must be considered by Examiner. M.P.E.P. § 2141; *see also In re Sernaker*, 702 F.2d 989, 996, 217 U.S.P.Q. 1, 7 (Fed. Cir. 1983). Moreover, such evidence "serve[s] as insurance against the insidious attraction of the siren hindsight" when evaluating the prior art. *W.L. Gore & Assoc. v. Garlock, Inc.*, 721 F.2d 1540, 1553, 200 U.S.P.Q. 303, 313 (Fed. Cir. 1983).

ii. The Examiner Did Not Properly Consider The Objective Evidence In The Advisory Action

In the Advisory Action having a mailing date of December 6, 2006, ("Advisory Action"), the Examiner noted that "neither preferential oxidation and/or separation using surfactants is recited in any of the instant claims.... Since the instant claims are substantially broad in nature and do not mention preferential oxidation and/or separation using surfactants, it is maintained that it would have been obvious at the time of invention to combined [*sic*] the process of Hiura and Iijima to obtain the instant invention regardless of how 'difficult' Dujardin believed it to be." Advisory Action, at 2.

Examiner further contends that "Dujardin teaches that efforts to end derivatize single walled nanotubes were directed at modifying other techniques originally developed for multishell nanotubes. Therefore, it would have been obvious according to Dujardin to use the technique of Hiura to end derivatize single shelled nanotubes, since Hiura was a technique originally developed for multishell nanotubes." *Id.*

Regarding the Examiner's statements in the Advisory Action, Applicant believes that the Examiner is misguided in these statements.

First, regarding how "difficult" *Dujardin* believed the purification of single-shell nanotubes were, based on preferential oxidation and/or separation using surfactants versus that of multishell nanotubes, Applicant contends that there is no requirement that claims of the instant invention recite any particular type of derivatization such as preferential oxidation and/or separation.

Second, regarding the Examiner's contention that "*Dujardin* teaches that efforts to end derivatize single walled nanotubes were directed at modifying other techniques originally developed for multishell nanotubes." (*Id.*), the Examiner apparently misread the statement in *Dujardin*, which states "So efforts have been directed at modifying other techniques originally developed for multishell nanotubes." (*Dujardin* at 611, Col. 1, par. 2) The "efforts" refer to ***purification***, not ***end-derivatization***. This is substantiated by the end note references [9] and [10] in *Dujardin* that are associated with this statement and are directed at ***purification*** techniques that do not involve oxidation or derivatization of any kind. End note reference [9] refers to Tohji, *et al.*, "Purification Procedure for Single-Wall Carbon Nanotubes," *J. Phys.*

Chem. B **1997**, 101, 1974-1978, ("*Tohji*"); and end note reference [10] refers to "Purification of Single-Wall Carbon Nanotubes by Microfiltration," by Bandow, et al., *J. Phys. Chem. B* **1997**, 101, 8839-8842, ("*Bandow*"). Like *Bandow*, *Tohji* does not teach any derivatization or oxidation of single-wall carbon nanotubes. *See Tohji,* attached at Exhibit C hereto.

Therefore, in light of all of the foregoing and because a *prima facie* case of obviousness has not been established for Claim 84, this Claim cannot be held obvious under 35 U.S.C. § 103(a).

2. Claim 85

For the reasons discussed in Section VII.B.1 above, a *prima facie* case of obviousness has not been established for Claim 85. Therefore, this Claim cannot be held obvious under 35 U.S.C. § 103(a).

3. Claim 91

For the reasons discussed in Section VII.B.1 above, a *prima facie* case of obviousness has not been established for Claim 91. Therefore, this Claim cannot be held obvious under 35 U.S.C. § 103(a).

4. Claim 92

For the reasons discussed in Section VII.B.1 above, a *prima facie* case of obviousness has not been established for Claim 92. Therefore, this Claim cannot be held obvious under 35 U.S.C. § 103(a).

5. Claim 94

For the reasons discussed in Section VII.B.1 above, a *prima facie* case of obviousness has not been established for Claim 94. Therefore, this Claim cannot be held obvious under 35 U.S.C. § 103(a).

6. Claim 95

For the reasons discussed in Section VII.B.1 above, a *prima facie* case of obviousness has not been established for Claim 95. Therefore, this Claim cannot be held obvious under 35 U.S.C. § 103(a).

We believe there are no fees due at this time, however, if we have calculated incorrectly, authorization is hereby given via the Electronic Filing System (EFS) by way of Deposit Account authorization. Please apply all charges or credits to Deposit Account No. 06-1050, referencing Attorney Docket No. 21753-011014.

Date: 7/5/07

Respectfully submitted,

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CLAIMS APPENDIX

84. A method for producing end-derivatized single-wall carbon nanotubes comprising the steps of:

a) providing a plurality of single-wall carbon nanotubes; and

b) reacting the single-wall carbon nanotubes with a compound that provides at least one substituent on at least one of the ends of at least a portion of the single-wall carbon nanotubes.

85. The method of claim 84 wherein the at least one substituent is selected from the group consisting of alkyl; acyl; aryl; aralkyl; halogen; substituted thiol; unsubstituted thiol; substituted amino; unsubstituted amino; hydroxy; and OR', wherein R' is selected from the group consisting of alkyl, acyl, aryl, aralkyl, halogen, substituted thiol; unsubstituted thiol; substituted amino; unsubstituted amino, a linear carbon chain and a cyclic carbon chain and wherein the linear carbon chain, the cyclic carbon chain, or both are (a) optionally interrupted with one or more heteroatom and (b) optionally substituted with one or more =O, or =S, hydroxy, an aminoalkyl group, an amino acid, or a peptide of 2-8 amino acids.

91. A method for producing end-derivatized single-wall carbon nanotubes comprising the steps of:

a) providing a plurality of single-wall carbon nanotubes, wherein the carbon nanotubes comprise at least about 100 carbon atoms; and

b) reacting the single-wall carbon nanotubes with a compound that provides at least one substituent on at least one of the ends of at least a portion of the single-wall carbon

nanotubes.

92. The method of claim 91 wherein the at least one substituent is selected from the group consisting of alkyl; acyl; aryl; aralkyl; halogen; substituted thiol; unsubstituted thiol; substituted amino; unsubstituted amino; hydroxy; and OR', wherein R' is selected from the group consisting of alkyl, acyl, aryl, aralkyl, halogen, substituted thiol; unsubstituted thiol; substituted amino; unsubstituted amino, a linear carbon chain and a cyclic carbon chain and wherein the linear carbon chain, the cyclic carbon chain, or both are (a) optionally interrupted with one or more heteroatom and (b) optionally substituted with one or more =O, or =S, hydroxy, an aminoalkyl group, an amino acid, or a peptide of 2-8 amino acids.

94. The method of claim 84, wherein the ends of the single-wall carbon nanotubes are open, closed, or a combination thereof.

95. The method of claim 91, wherein the ends of the single-wall carbon nanotubes are open, closed, or a combination thereof.

EVIDENCE APPENDIX

(1) *Dujardin et al.*, "Purification of Single-Shell Nanotubes," Adv. Mater.. 10, No. 8, 611-613 (1998) which was attached to the Amendment Under 37 C.F.R. § 1.111, filed June 26, 2006, of the present Application and entered by the Examiner. This paper is attached to this Brief at Exhibit A.

(2) H. Hiura, T.W. Ebbesen, K. Tanigaki, "Opening and Purification of Carbon Nanotubes in High Yields," *Adv. Mater.*, **1995**, 7, 275, which was attached to the Amendment Under 37 C.F.R. § 1.116, filed November 13, 2006 and entered by the Examiner. This paper is attached to this Brief at Exhibit B.

(3) Tohji, *et al.*, "Purification Procedure for Single-Wall Carbon Nanotubes," *J. Phys. Chem. B* **1997**, 101, 1974-1978, which was submitted in the present Application in an Information Disclosure Statement, dated February 26, 2004, Ref BTB, and considered by the Examiner on March 16 2006. This paper is attached to this Brief at Exhibit C.

No other evidence was submitted pursuant to §§1.130, 1.131, or 1.132 of 37 C.F.R. or of any other evidence entered by the Examiner and relied upon by Appellants in the Appeal.

RELATED PROCEEDINGS APPENDIX

There are no related proceedings to the current proceeding.

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